Synopsis for Pre–D.Sc Registration

Assessing the impact of some Medicinal and Aromatic Plant (MAP) cultivation on socio-economic conditions in selected areas of Jharkhand.

In

BOTANY

(Faculty of Science)

Submitted by

Dr. SOUGATA SARKAR
M.Sc, Ph.D Plant Science (JNU-CSIR-CIMAP, Lucknow, U.P.), Post Doctorate.
Assistant Professor, Department of Botany, Radha Govind University, Ramgarh, Jharkhand.

<u>Under the supervision & guidance of</u>

Dr. ARUN KUMAR.
Associate Professor,
Dean & Head, University Department of Botany,
Ranchi University, Ranchi, Jharkhand - 834001.

Assessing the impact of some Medicinal and Aromatic Plant (MAP) cultivation on socio-economic conditions in selected areas of Jharkhand.

1. State of Art

The World Bank once upon a time identified Jharkhand (Fig. 1) as one of the most poverty-stricken state in the country with a sharp contrast between rural and urban poverty (World bank, 2007). This indelible remark was slowly and steadily being overcomed and now as per Jharkhand State Report, June 2024, Jharkhand is one of the leading states in terms of economic growth as gross state domestic product (GSDP) estimated to stand at ~Rs. 4.7 trillion (US$ 56.78 billion) in 2024-25. Mineral production in the state stood at 138.15 million tons in FY23. According to the Department for Promotion of Industry and Internal Trade (DPIIT), cumulative foreign direct investment (FDI) inflows in Jharkhand stood US$ 2.66 billion between October 2019-March 2024. Total exports from the state stood at US$ 1.9 billion in 2023-24 compared to US$ 1.39 billion in 2022-23. About 80% of the rural population of the state depends on agriculture. Rice is the major food crop of the state, covering 80% of the cropped area.

Therefore, apart from employment derived from tremendous growth and development in industrial sector (mineral reserves, mining and mineral extraction where mineral production in the state stood at 138.15 million tons in FY23) Jharkhand also follows an agrarian scheme of cultivation of food crops (Sucharita, 2020). Majorities of rural population of Jharkhand stick to the agricultural ecosystem of employment and make the ends meet. Out of a total geographical area of 7.9 million ha, nearly 2.6 million ha are cultivated, while 2.3 million ha (29% of total area) are under forests. The area under assured irrigation is less than 10 percent. Out of a total population about 78% live in villages, while about 22% reside in urban areas. Nearly 49% of the population lives below the poverty line. Rural poverty is greater than urban poverty. It may be said that agro-ecological and social factors are the main causes for rural poverty in Jharkhand. Poor infrastructure, difficult terrains, high population pressure on arable land, low coverage of irrigation, limited *in-situ* employment opportunities, social customs and traditions, natural calamities like drought are some of the factors that inflict poverty in the state.

In Jharkhand, about 92% of the cropped area is under paddy, wheat, maize, pulses and oilseeds (Niger, linseed and mustard). The productivity of crops is low and the deficit with reference to demand and supply is as high as 52% in the case of cereals, 65% in the case of

fruits, 51% in the case of milk and 34% in the case of fish. Only one crop is taken during the kharif season in most parts of the state and **current fallow and other fallow lands (Table 1) contribute 2.0 million ha (about 25% of the area)**. It is thus clear that accelerated agriculture development holds the key to poverty eradication and employment generation in the state (Corbridge, 1998).

Unit	Number
District	24
Block	259
Panchayat	4,423
Village	32,615

Source : Census of India, 2011

Figure 1: Administrative units and district boundary of Jharkhand

Table 1: District-wise land use statement of Jharkhand in 2004-05 ('000ha)

District	Forest Area	Not Available for Cultivation	Other Cultivable Land excluding Fallow Land	Fallow Land	Net Area Sown	% of Net Area Sown in TGA
Ranchi and Khunti	159.14	114.00	39.05	**190.21**	255.85	33.7
Simdega	55.94	51.29	25.18	**157.55**	81.67	22.0
Purbi Singhbhum	122.82	197.60	33.33	**119.66**	83.28	15.0
Pashchimi Singhbhum	227.54	79.54	35.10	74.53	145.99	25.9
Saraikela-Kharsawan	95.96	35.13	15.28	30.44	60.42	25.5
Chatra	226.82	30.40	11.26	61.97	45.07	12.0
Palamu	226.85	51.60	19.36	**129.13**	97.75	18.6

Garhwa	191.15	39.85	11.71	**121.34**	64.77	15.1
Latehar	137.97	31.53	11.53	78.39	59.77	18.7
Ramgarhand Hazaribagh	256.66	91.77	20.88	**129.18**	106.14	17.6
Kodarma	55.23	23.95	6.32	27.66	17.04	13.1
Giridih	158.42	64.04	41.41	**151.76**	77.59	15.7
Bokaro	72.23	71.03	14.63	**115.57**	15.51	5.4
Dhanbad	18.93	75.74	15.17	59.72	34.60	16.9
Dumka	42.71	65.99	49.48	**101.75**	119.10	31.4
Deoghar	34.63	32.71	28.55	88.58	63.68	25.7
Godda	31.32	26.79	16.04	79.48	78.21	33.7
Pakur	20.79	27.17	18.47	57.43	57.84	31.8
Sahibganj	42.74	30.11	12.31	75.13	41.46	20.6
Jamtara	30.20	30.19	22.40	41.04	55.34	30.9
Lohardaga	44.36	18.88	11.26	39.48	39.64	25.8
Gumla	81.14	74.74	36.63	**184.66**	161.75	30.0
Total	2,333.55	1,264.05	495.35	**2,114.66**	1,762.47	22.1

Source : Directorate of Statistics and Evaluation, GoJ

The prosperity of agrarian socio-ecosystem has always been on the mercy of different environmental factors like rainfall (no or scanty leads drought, excessive leads to flood), cyclones, storms, pest infestation, epidemic / pandemic like COVID (Sarkar *et al*, 2022) and so on. Farmers, growers who solely depend on agriculture become restless, helpless when affected by any one or more of these factors. Hence, economic losses are inevitable and prevail side by side. Moreover, lack of education (Rana, & Das, 2004; Higham & Shah, 2013), poor land base with small and marginal land holdings, poor quality of natural resources like - acidic, laterite and red soils, water scarcity leading to mono-cropping, changing climatic scenario and undulating terrain lacking capacity to retain rain water forces the farmers to take a single crop in the state, thereby reducing the opportunities to a better livelihood compounds the problem of rural agrarian poverty in Jharkhand.

Thus, suitable and sustainable measures need to be taken to relieve our rural farmers affected from uncontrollable environmental factors. Cultivation of some non-conventional crops – MAPs having immense demand in national and international market brings hope. Aromatic crops are less demanding, require fewer inputs, can be grown on fallow (non-agricultural) land, ungrazable by live-stocks, have broader harvest time, yield valuable essential oil and are economically profitable – as on one hand MAPs double farmers' income during good conventional harvest and on the other hand provide a reliable economic backup during bad conventional harvest. This study will be focused to realize the importance of MAPs cultivation in

the socio-economic upliftment of rural/agrarian parts of Jharkhand and identifying best performers in Jharkhand's agro-ecosytem.

Medicinal and Aromatic Plants (MAPs)

Cultivation of Medicinal and Aromatic Plants (MAPs) for human welfare has been in practice since ancient times. A significant rise in MAPs cultivation throughout India has resulted after CSIR-Aroma Mission Mega Project – 1st, 2nd now 3rd phase (4th June, 2023 "Catalyzing rural empowerment through Cultivation, Processing, Value addition and Marketing of Aromatic Plants")

The first phase of CSIR-Aroma Mission, was launched on 1st April 2016 was completed on 31st March 2019 and the second phase was launched on April 2020 was completed on March 2023. First and Second phase of CSIR-Aroma Mission has brought a transformative change in the aroma sector through scientific interventions in the area of agriculture, processing, and product development by fuelling the growth of the aroma industry and rural employment. The mission promoted the cultivation of aromatic crops for essential oils that are in great demand by aroma industry. It enabled Indian farmers and aroma industry to become global leaders in the production and export. This provided substantial benefits to the farmers in achieving higher profits, utilization of waste lands and protection of their crops from wild and grazing animals (Kumar & Venkatasubramanian, 2022).

Under the third phase an area of 2400 hectares will be brought under cultivation for these crops by interventions of CSIR to further catalyze cultivation of aromatic crops in about 60,000 hectares. Moreover, about 200 training/ awareness programmes will be conducted during the tenure of Aroma Mission phase III. An additional 700 tones of essential oil is expected to be produced annually for perfumery, cosmetics and pharmaceutical industries and use of these oils in value addition and herbal products would generate a business of at least 200 crores. The activities of the Mission will improve availability of quality planting material (QPM) on sustainable basis for a boom in the herbal industry based on essential oils (Lal *et al*, 2020). The mission will put a mechanism in place for timely agro-advisory, ensuring optimal productivity and fair price of the produce to the farmers and reducing the import of essential oils (Lal *et al*, 2020) and enabling India to become leading exporter of at least some essential oils (Barik, 2022).

Success stories

The scientific interventions made under the Aroma mission project have provided benefits to the growers of Vidarbha, Bundelkhand, Gujarat, Marathwada, Rajasthan, Andhra Pradesh, Odisha and other states where farmers were exposed to frequent episodes of weather extremes and account for maximum suicides.

This Mission aims to achieve following outcomes:

- Bring about 2400 ha of additional area under captive cultivation aromatic cash crops particularly targeting rain-fed /degraded land across the country.
- Provide technical and infrastructural support for distillation and value-addition to farmers/growers all over the country
- Enabling effective buy-back mechanisms to assure remunerative prices to the farmers/growers
- Value-addition to essential oils and aroma ingredients for their integration in global trade and economy

2. Problem to be investigated.

Disparity exists between the socio-economic status of urban and rural (Singh *et al*, 2011) Jharkhand inspite of the fact that the state is one of the richest in mineral deposits in the world and boasts 40% and 29% of India's mineral and coal reserves, respectively. Mineral production in the state stood at 138.15 million tons in FY23. The state has coal (27.3% of India’s reserves), iron ore (26% of India’s reserves), copper ore (18.5% of India’s reserves), uranium, mica, bauxite, granite, limestone, silver, graphite, magnetite and dolomite. Jharkhand is the only state in India to produce coking coal, uranium, and pyrite. With 26% of the total iron ore (hematite) reserves, Jharkhand ranks second among the states (Islam, 2015). The state’s industries enjoy a unique location-specific advantage as it is close to the vast market of eastern India. It is closer to the ports of Kolkata, Haldia, and Paradip which helps in the transportation of minerals. According to the Department for Promotion of Industry and Internal Trade (DPIIT), cumulative foreign direct investment (FDI) inflows in Jharkhand stood US$ 2.66 billion between October 2019-March 2024.

Out of a total of 127 agro-climatic sub-zones identified in India under the National Agricultural Research Project based on rainfall pattern, soil type, availability of irrigation water, existing cropping pattern and administrative units, Jharkhand alone has three agro-climatic sub-zones: Central North Eastern Plateau, Western Plateau, and South Eastern Plateau.

Furthermore, the National Horticulture Mission (NHM) has classified the state into six regions in terms of horticulture production – Moderate temperature during summer, rainfall of 1020.8 mm; Relatively warmer and humid climate, rainfall of 1011.3 mm and climate is affected by sea changes; Dry climate with less rainy days and low rainfall of 813.7 mm; Warmer climate, average rainfall of 1046.7 mm and concentration of injurious gases in air from coal burning; Warmer climate with high rainfall; Cooler region on altitude between 800 m and 1,300 m above sea level.

In Jharkhand, soils in about 49% of the total geographical area are highly acidic with pH ranging from pH 4.5 to 5.5. Neutral soils (pH 6.6 to 7.3) accounts for only about 8%. The level of soil organic carbon content of about 47% of the total geographical area (TGA) ranges from low to medium (<0.5% to 0.75%). Soils of the majority area (about 70% of TGA) of the state have medium available nitrogen (N) content (280 to 560 kg/ha) and about 19.6% of the area has low available N content (<280 kg/ha). Soils of about 66% of the area are low (<10 kg/ha) in available phosphorous (P) content whilst about 28% of the area are found to be medium (10 –25 kg/ha) in available P content. Most of the soils (about 51% of TGA) have medium available potassium (K) content and about 18% are low (below 108 kg/ha) in available potassium content. Soils of about 38% of the area are low (<10 mg/kg) whereas soils of about 31% are medium (10-20 mg/kg) in available sulphur content. All the soils are sufficient in iron (more than 4.5 mg/kg) and manganese (more than 2.0 mg/kg), whilst about 7% of the area is deficient in available zinc content (less than 0.5 mg/kg), 4% of soils are deficient in copper content (less than 0.2 mg/kg), and about 45% of soils are deficient in available boron content (less than 0.5 mg/kg).

Jharkhand has three seasons, namely, monsoon, winter, and summer. Monsoon season generally starts in June and ends in September, more than 80% of annual rainfall is observed in this season. The sunshine hours are only 4.6 hours per day on average, which is shorter than other seasons. The monthly mean minimum temperature is stable at around 23 ˚C in this season, which is higher than summer season. Winter season lasts for five months from October to February, with a monthly mean minimum temperature of 11.3 ˚C. The minimum temperature of 0.0 ˚C was recorded. The sunshine hours are more than eight hours per day, which is the same

level as summer season. Summer season is from March to May, with a monthly mean maximum temperature of 34.4 ˚C and the maximum temperature of 54.6 ˚C was recorded. Summer season has high temperature, low humidity and high evaporation.

The topography of Jharkhand represents hilly and undulating terrain. The altitude varies from 40 m to 1,366 m. The west central part of Jharkhand State shows high mountainous area. Toward north, east, and south from the mountainous area, the altitude is getting lower gradually. Most of the area forms peneplain. The continental crust was uplifted, followed by a very long period of weathering and erosion of the uplifted mountain, and finally peneplain was formed. Inselberg is a remaining hill in such peneplain. Along the northeastern end of Jharkhand State, the Ganges River is flowing from west to south.

Rivers form river basins depending on the topography. Jharkhand is divided into 16 river basins. Presently, the availability of water resource is estimated at 28,781 million cubic meters (MCM), out of which 23,789 MCM is from surface water and the rest of about 4,992 MCM is from groundwater. On the other hand, the total utilisation of surface water and groundwater in the state for irrigation purposes is estimated at 4,736 MCM, of which 3,964 MCM is surface water and 772 MCM is groundwater, according to the Department of Agriculture and Sugarcane (DoA). The total irrigable area of 2,365 km^2 accounts for less than 3% of the total land area of the state.

So, by looking at all the above data one can easy conclude that nature has blessed the state of Jharkhand which all that can be provided yet economic and social disparity still exists between the urban and rural areas mainly because of lack of education, poor land base with small and marginal land holdings. Lack of employment opportunities at local level and poor infrastructure compounds the problem. In addition to these factors, poor quality of natural resources like; acidic, laterite and red soils, water scarcity leading to mono-cropping in the state have also contributed towards rural poverty. With changing climatic scenario and undulating terrain lacking capacity to retain rain water forces the farmers to take a single crop in the state, thereby reducing the opportunities to a better livelihood.

The rural Jharkhand, the agrarian suffers from so many day to day challenges. One of them is the environmental fluctuations that affect them harshly. Agricultural produce still depends largely on the blessings of mother Nature. Inadequate rainfall, irrigation, cyclones, storms, pests, diseases can alter the fate of good agricultural output. The rural farmers are

courageous, knowing the above facts they do their best to get a good produce. Sometimes, luck does not favor hard work and economic losses are inflicted upon them. In the recent past frequency of such hard lucks have been increasing in agro-ecosystem of Jharkhand and therefore farmers need to be protected with a backup mode of income, so that economic losses can be overcomed. In this kind of scenario cultivation of non-conventional crops like MAPs come into play. Medicinal and Aromatic plants are highly valuable agriculture commodity that are significantly providing employment opportunities, handsome money and contributing desperately to upgrade the food security condition in different states of India. Despite of having immense natural potentialities (as described above) to promote MAP cultivation, Jharkhand is still far behind to grab the opportunities utilizing available resources. Hence, feasibility study for the commercialization of the MAPs in the state is indeed needed to explore the potential of the MAPs cultivation in large scale to boost the rural economy. MAPs cultivation and marketing is one of the realms of agriculture which could transform the state's rural poverty to prosperity. Since commercialization of MAPs will provide employment, income and the necessary medicine and oils to the farmers. At the same time, farmers can locally process MAPs to prepare the local medicine using their indigenous skill and knowledge. Cultivation and commercialization of MAPs (Gupta *et al*, 2015) will also widen the scope of the establishment of the processing centers and the industries related to it. Due to all these reason and strong evidences, this study is imperative for the upgrading the rural economy through promoting the cultivation, trade and processing of the medicinal and aromatic plants (MAPs).

3. Objectives of investigation and motivation

In order to minimize the existing socio-economic disparity among rural and urban Jharkhand and to ensure doubling of farmers' income during good conventional yield and backup economic security during bad conventional yield, MAPs cultivation indeed is the best option available for agro-economic system of Jharkhand. Thus, objectives of the study relevant to addressing the problem are as following :

1. **Identification of those locations in Jharkhand where MAPs cultivation is under operation for livelihood maintenance, support system and trade.**
2. **To ascertain those cultivars/varieties of MAPs preferred by farmers of Jharkhand for cultivation that proved to be useful in addressing their socio-economic issues.**

3. **To understand the socio-economic problems that prevailed in those locations and how well has MAP cultivation addressed them.**
4. **Assessment of some morphometric and chemometric traits of MAP cultivars/varieties in those identified locations of Jharkhand.**
5. **Identifying the best performers among the MAPs crops that proved to be reliable income generator for farmers of Jharkhand.**

4. Hypothesis

Cultivation of low demanding, region-specific, market oriented Medicinal and Aromatic Crops in fallow/non-arable land in consonance to existing conventional cultivation in arable/fertile land will lead to increase in farmers' income, bring sustainable socio-economic growth, help in reducing disparity in rural and urban economy in Jharkhand.

5. Research design and Methodology

Sl. No.	Particulars	Details
1.	Site of study	Farmers' field in selected locations of Jharkhand.
2.	Data Type	Primary numerical data (quantitative).
3.	Nature of data	Quantitative data analyzable with a statistical methods to perform valid statistical analysis like measures of central tendencies, ANOVA, correlation, comparisons, path analysis, interaction studies etc. Qualitative data obtained after interactions.
4.	Form of data collection	Field Surveys : to collect primary field data. Closed-ended questions: focused on the end goal of the research

Schematic representation of some closed ended questions:

Sl No	Location details	Farmer's details	Source of income and way of life before MAP cultivation	Name of MAP under cultivation	Effect on farmer's income and way of life by MAP cultivation

(Note: Format may be modified during survey)

6. Material and methods

1. Training for cultivation and oil extraction may be arranged for potential and deserving farmers.
2. Schemes and benefits for MAP cultivation may be updated as and when required to farmers associated to MAP farming.
3. Effect on socio-economic condition before and after MAP cultivation will be evaluated.
4. Morphometric and chemometric data of some MAP cultivars growing in farmers field will be recorded for statistical analysis. Some of the common traits (Yogendra *et al*, 2021; Sarkar *et al*, 2021; Sarkar *et al*, 2022) are :

(a) Plant height (cm)
(b) Spread (cm)
(c) Number of branches/plant
(d) Oil content (%)
(e) Herb yield/plot (kg/plot)
(f) Oil yield/plot (ml/plot)
(g) Harvest index (ml/kg)
(h) Essential oil component (%)

5. Location of study :

   Such locations in Jharkhand with proper GPS coordinates where MAPs cultivation is practiced like Khunti, Gumla, Ramgarh, Hazaribagh, Bokaro, Dhanbad etc.

6. Tools to be used in collection of data :
   a) Tools for measurement of length (meter scale, 50m tape).
   b) Tool of weighing (an electronic balance with adequate precision).
   c) Hard bound register to record data.
   d) A digital camera with better resolution.
   e) A suitable laptop computer for data entry, analysis, storage, retrieval and other activities.
   f) Different useful and relatable software like SPSS, Endnote, Photoshop etc.
   g) Other accessories and stationeries.

7. Significance of the study

The main reason to continue with the above study is to help the farmers of Jharkhand during their tough time. We eat; we get our food because they produce them for us. So, it is a duty of every citizen like me to help them out in a sustainable way.

Other reasons are to support the rural-agrarian economy of Jharkhand from degrading further away and a marvelous scope to reduce the gap of rural and urban economic disparity by MAPs cultivation.

The plot of land which is fallow, unused are the target areas where MAPs cultivation can be done. Hence, fertile plots of land remain for the main crops and no selection pressure is prevalent. Therefore, cultivation of less demanding, export oriented, high demanding MAPs in parallel to main crops will double farmers' income during good times and during bad times it will prove to be a backup and help the farmers escape financial losses due to any biotic or environmental factors.

To present a "success model" to motivate other farmers of the state.

To know that "Nature has given us everything for our need but not for our greed."

Hence, the significance of this study.

8. Its relevance to the present day problem and need of the society

A fruitful SOCIETY is a unit of a fruitful NATION. A lot of effort is needed to develop such a fruitful society where all can contribute to peacefully co-exist and participate in its growth and development. This makes a larger society i.e. a country prosperous, powerful and independent.

In a society (Jharkhand as a state) where the producers (farmers) have no/negligible financial insurance against odds of natural forces, disparity (among socio-geographical-economy) is bound to prevail. The interests of the producers of different conventional crops (Table 2) need to be safeguarded in all ways. One of the many ways is cultivation of MAPs in fallow lands along with cultivation of traditional crops in fertile land. This will be a **triple boon** for famers of Jharkhand – reclamation of fallow land into cultivable land, doubles farmers'

income during good traditional harvest and lastly genuine economic security in the form of back up support during failed or low traditional harvest.

Thus, in order to get double profit, economic security and reclamation of wasteland, cultivation of specific MAPs suitable to agro-climatic condition of Jharkhand is a rational decision.

Table 2: List of major traditional/conventional crops grown across Jharkhand in 2004-2005 as compared with India.

Crops		**% Share of Total Cropped Area**		**Difference (A)-(B)**
		Jharkhand(A)	All-India (B)	
Cerealsand Millets	Rice	57.74	22.33	+35.41
	Maize	8.64	3.94	+4.70
	Wheat	2.94	13.89	-10.95
	Ragi	0.79	0.87	-0.08
	Other Cereals	0.06	10.54	-10.48
Pulses	Gram	1.52	3.52	-2.00
	Tur	4.02	1.84	+2.18
	Other Pulses	7.68	7.07	+0.61
Horticulture Crops	Fruit	1.51	2.04	-0.53
	Vegetables	**10.59**	**2.86**	**+7.73**
	Condiments and Spices	0.03	1.60	-1.57
Sugarcane		0.00	2.50	-2.50
NonFood Crops	Oil Seeds	4.28	15.89	-11.61
	Fibres	0.00	4.92	-4.92
	Fodder Crops	0.00	5.07	-5.07
	Other Non Food Crops	0.00	1.12	-1.12
Total		100.00	100.00	-

Source : Agricultural Research Data Book and Directorate of Agriculture, GoJ

MAPs cultivation in different states of INDIA has already begun during the first CSIR – Aroma Mission and had rapidly spread since then. The farmers of adjoining states Bihar, Uttar Pradesh and West Bengal have already adopted MAPs cultivation and are being benefitted socio-economically. However, trend of such a profitable non-conventional cultivation has just begun in a few places of Jharkhand. Inspite of having all the resources needed for a good MAP cultivation Jharkhand is falling behind at the present moment because of the lack of awareness.

Initiation of rapid MAP cultivation will bring out the solution to the problems associated with cultivation, improve the economy of farmers, transform non profitable fallow land into profitable arable land. All these actions will add to the knowledge about MAP cultivation in Jharkhand which is otherwise very scanty and will speak a lot about its relevance in the changing climatic condition.

9. Future work

A successful **MAP cultivation model of Jharkhand** needs to be exhibited to encourage, promote and advertise to other farmers of the state.

1. Screening and selection of specific MAP suitable of a particular locality/district.

2. Setting of commercial essential oil extraction units.

3. Value added products development.

4. Marketing of self made products.

REFERENCES

Barik, S. (2022). CSIR's cutting edge S&T in Agriculture, Nutrition and Biotechnology.

Corbridge, S. (1998). The ideology of tribal economy and society: Politics in the Jharkhand, Modern Asian Studies, 22(1), 1-42.

Gupta, P., Dhawan, S. S., & Lal, R. K. (2015). Adaptability and stability based differentiation and selection in aromatic grasses (*Cymbopogon species*) germplasm. Industrial Crops and Products, 78, 1-8.

Higham, R., & Shah, A. (2013). Affirmative action and political economic transformations: Secondary education, indigenous people, and the state in Jharkhand, India. Focaal, 2013(65), 80-93.

Islam, M. A., Rai, R., Quli, S. M. S., & Tramboo, M. S. (2015). Socio-economic and demographic descriptions of tribal people subsisting in forest resources of Jharkhand, India.

Kabeer, N., & Noponen, H. (2005). Social and economic impacts of PRADAN's self help group microfinance and livelihoods promotion program: analysis from Jharkhand, India.

Kumar, A., & Venkatasubramanian, K. (2022). CSIR Mission Projects Ushering in Socio-Economic Changes.

Lal, R. K., Chanotiya, C. S., Gupta, P., Deepa, B., & Mishra, A. (2020). Essential oils their quality assurance, management and stakes of CSIR-CIMAP (India): Past and future perspective. JMAPS, 42, 181-199.

Rana, K., & Das, S. (2004). Primary education in Jharkhand. Economic and Political Weekly, 1171-1178.

Sarkar, S., Meena, R., Verma, I., Pal, J., Kumar, K., Thapa, P. S., Chaurasia, V., Rahul, V. P. (2021). Genetic variability, character association and path analysis of oil yield and its component characters in *Cymbopogon sp*. Acta Ecologica Sinica, 41(6), 584-590.

Sarkar, S., Verma, I., & Thapa, P. S. (2022). Impact of total lockdown due to COVID19 on the agro-economic traits of lemongrass. J Appl Biotechnol Bioeng, 9(2), 25-31.

Singh, K. M., Meena, M. S., Kumar, A., & Singh, R. (2011). Socio-Economic Determinants of Rural Poverty: An Empirical Exploration of Jharkhand State, India. India.

Sucharita, S. (2020). Socio-economic determinants of temporary labour migration in Western Jharkhand, India. Millennial Asia, 11(2), 226-251.

Tilaye, M., Girma, T., & Philipose, M. (2018). Cost benefits Analysis of lemongrass (*Cymbopogon citratus* (DC) Stapf.) variety: WG-Lomisar-Java for herbal production at Wondogenet. Journal of Agricultural Economics and Rural Development, 4(2), 494-500.

World bank (2007). Jharkhand: Addressing the Challenges of Inclusive Development. Report No. 36437-IN Poverty Reduction and Economic Management. India Country Management Unit, South

Yogendra, N. D., Nazeer, M., Yadav, M. K., Baskaran, K., Pragadheesh, V. S., Jnanesha, A. C., & Srinivas, K. V. N. (2021). Comparative morphological assessment of lemongrass (*Cymbopogon spp*.) cultivars for oil yield, chemical composition and quality parameters under southern region of India. Madras Agricultural Journal, 108.